IMAGING MECHANISMS OF VISUAL ATTENTION

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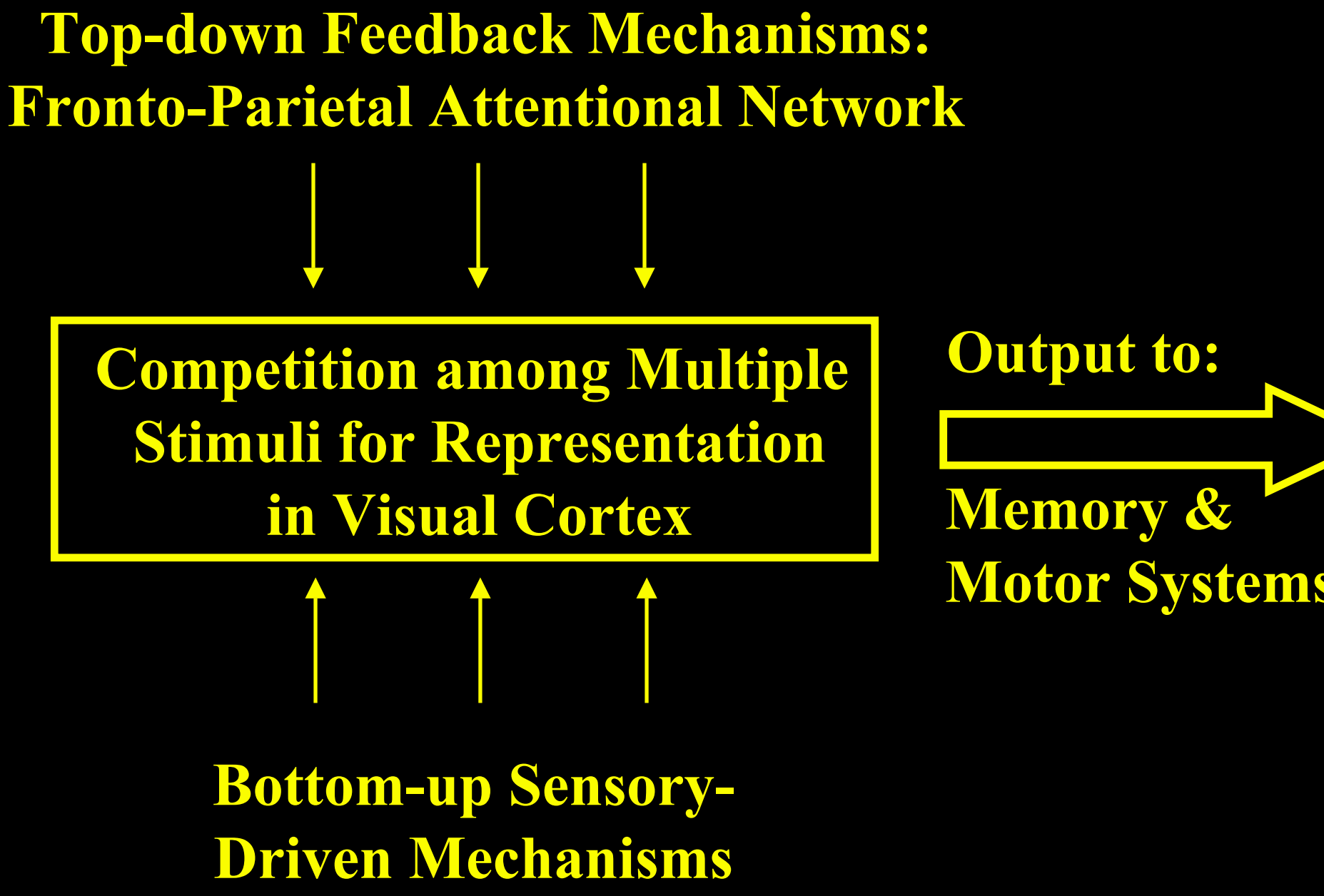
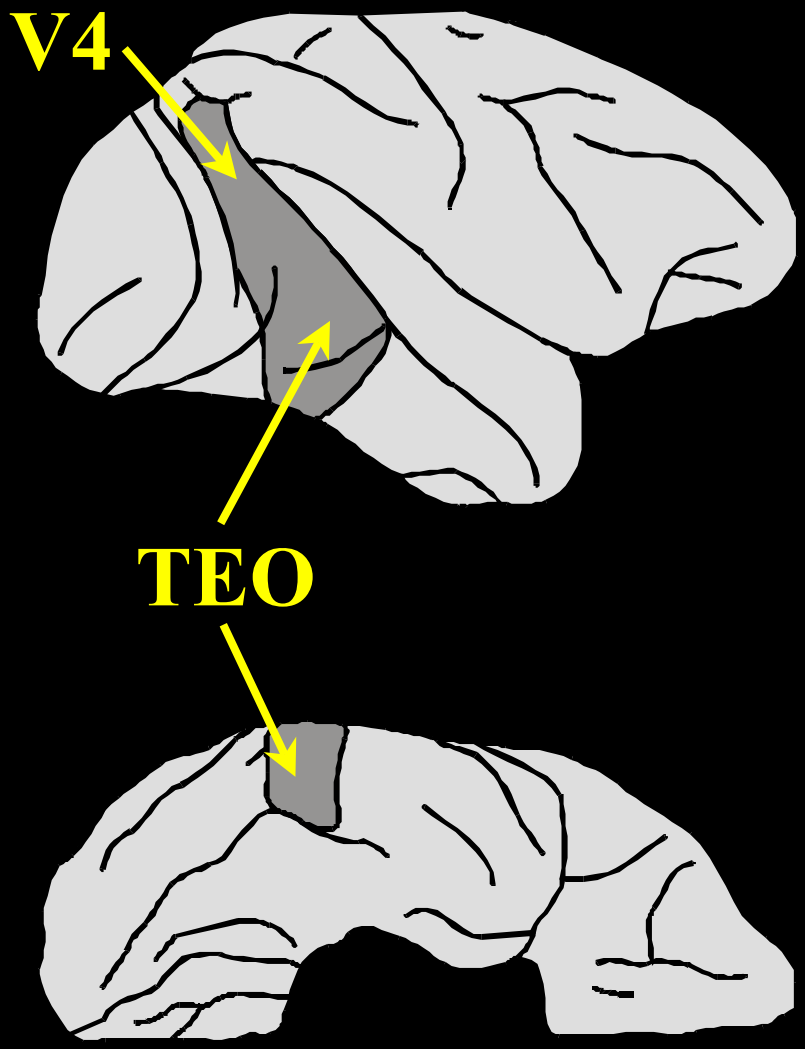
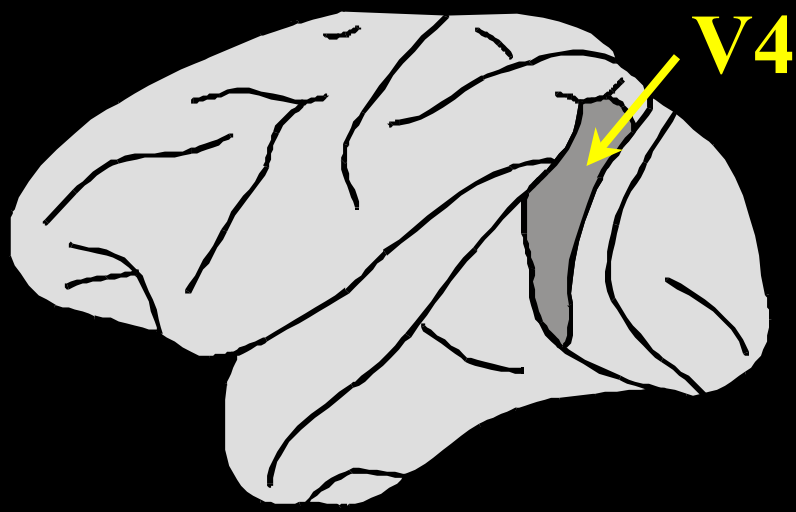
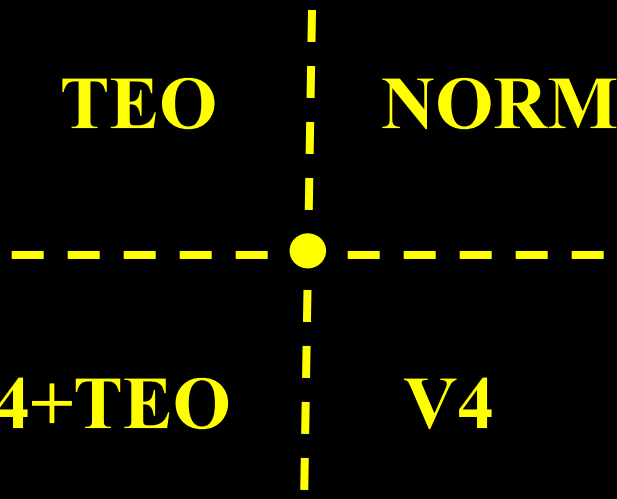

Top-down Feedback Mechanisms:
Fronto-Parietal Attentional Network
Competition among Multiple Stimuli for Representation in Visual Cortex
Output to:
Memory &
Motor Systems
Bottom-up Sensory-Driven Mechanisms

Lesions of Cortical Areas V4 and TEO

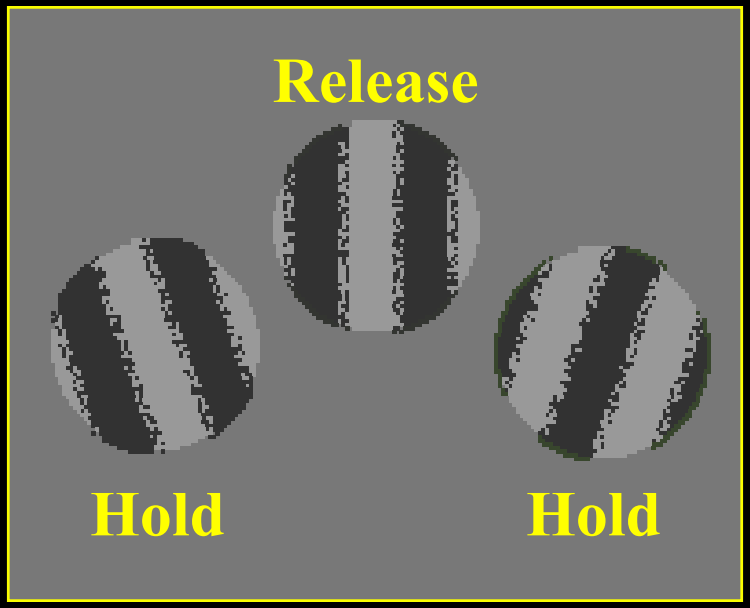


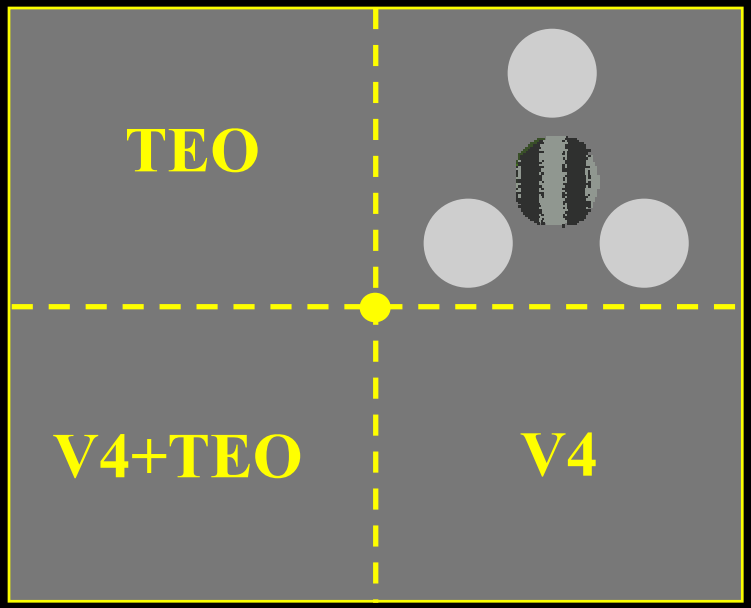


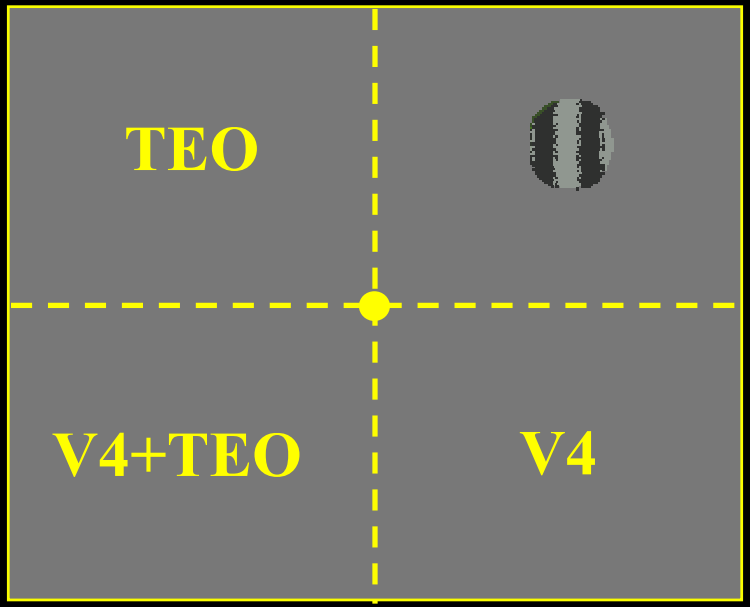


TASK

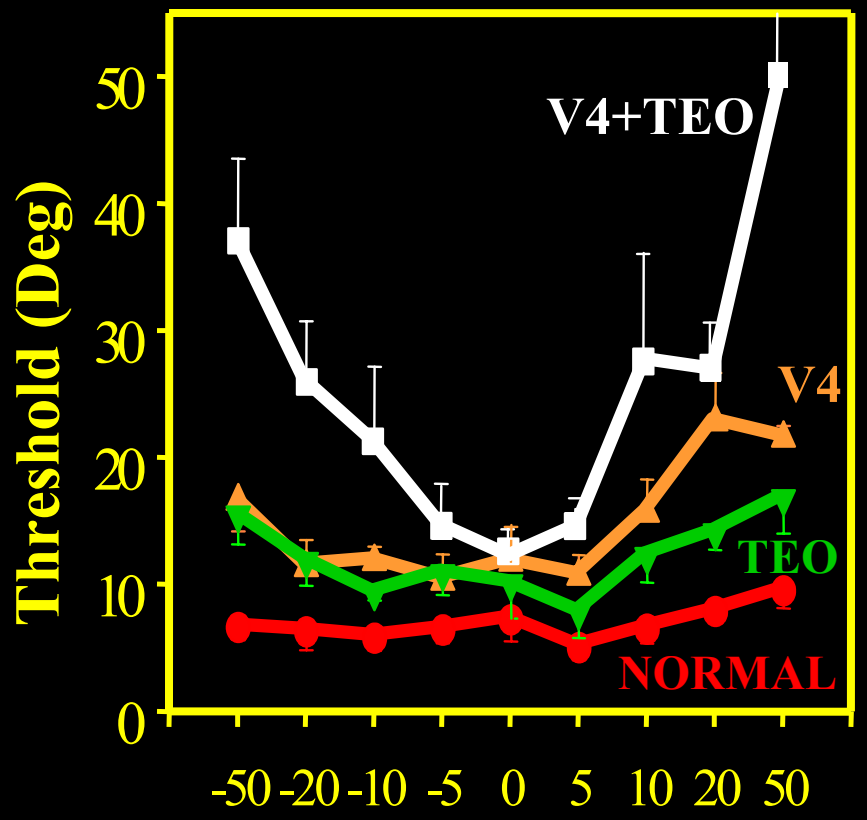
Orientation discrimination (84% correct thresholds) in each quadrant of the visual field

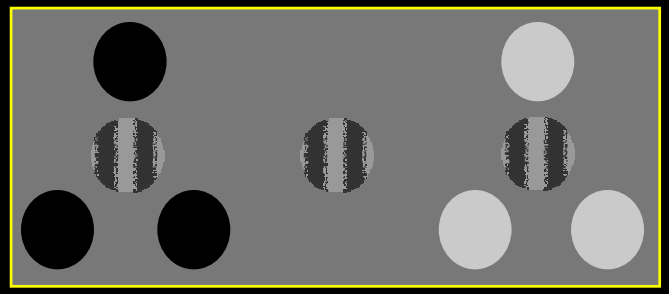




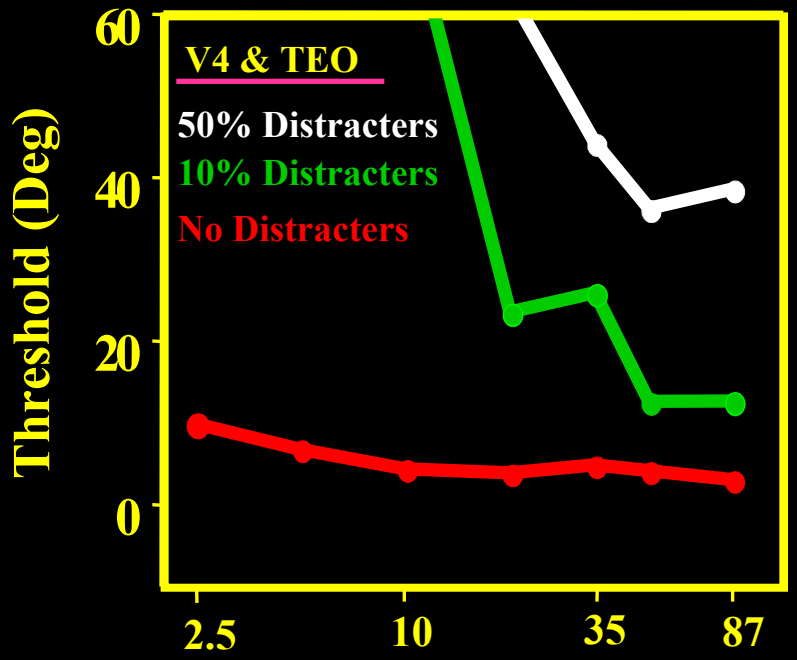


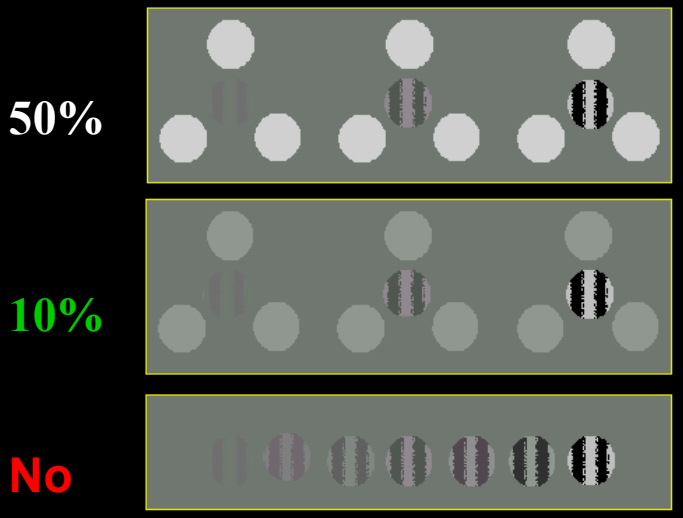
Orientation Discrimination:Effect of Distracter Contrast





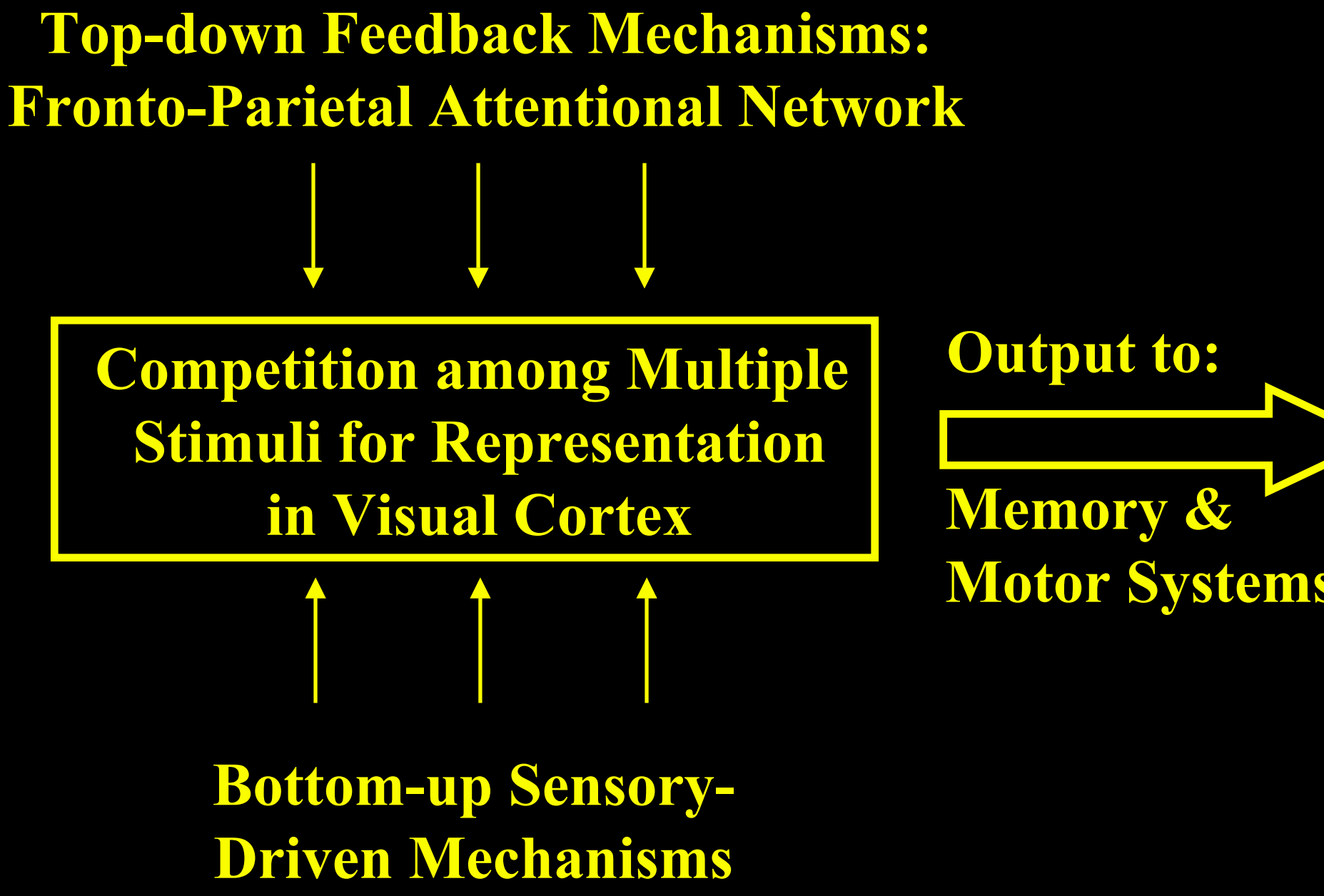
Orientation Discrimination: Effect of Target Contrast





Summary: Effects of V4 & TEO Lesions

- After lesions in areas V4 and TEO, the accuracy of target perception is determined by the contrast of the target relative to the distracters.
- Areas V4 and TEO may be sites where top-down attentional influences counteract bottom-up sensory input.


Top-down Feedback Mechanisms:
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Evidence for Top-down Fronto-Parietal Attentional Network

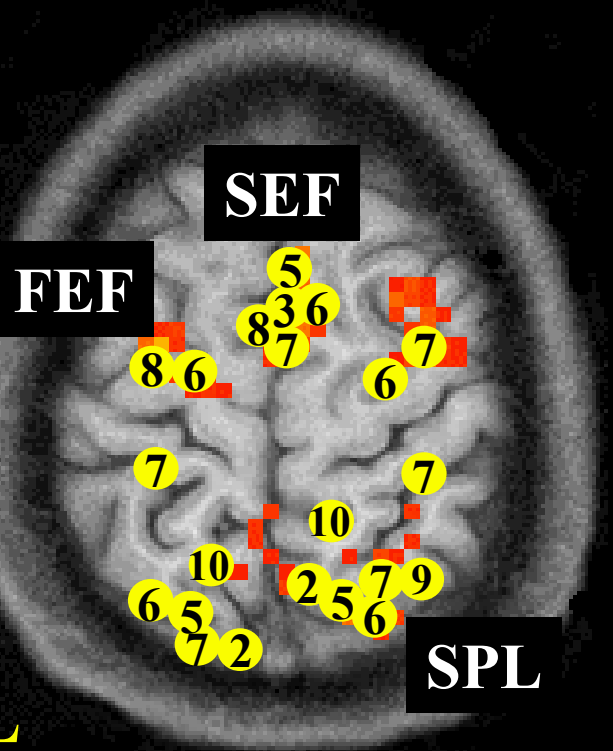
- Imaging evidence
- Anatomical evidence
- Lesion evidence

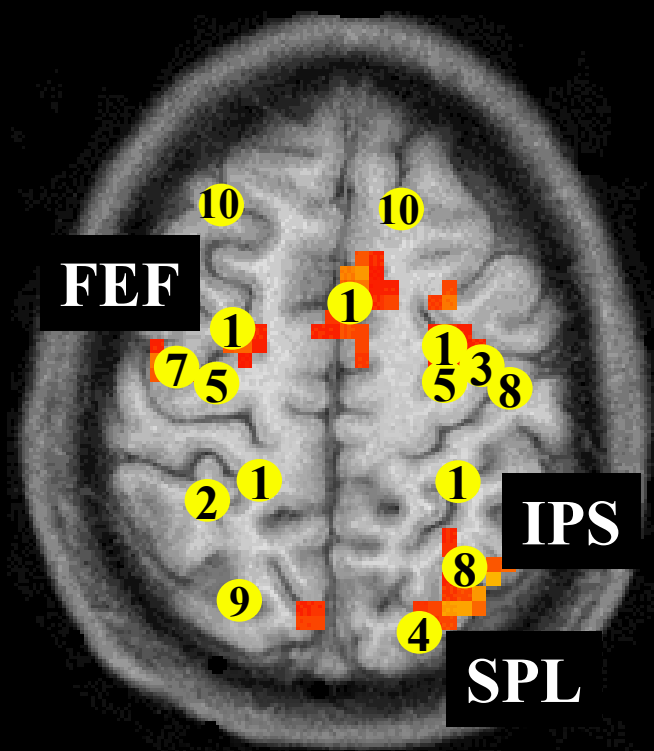
Attentional Network: Meta-Analysis

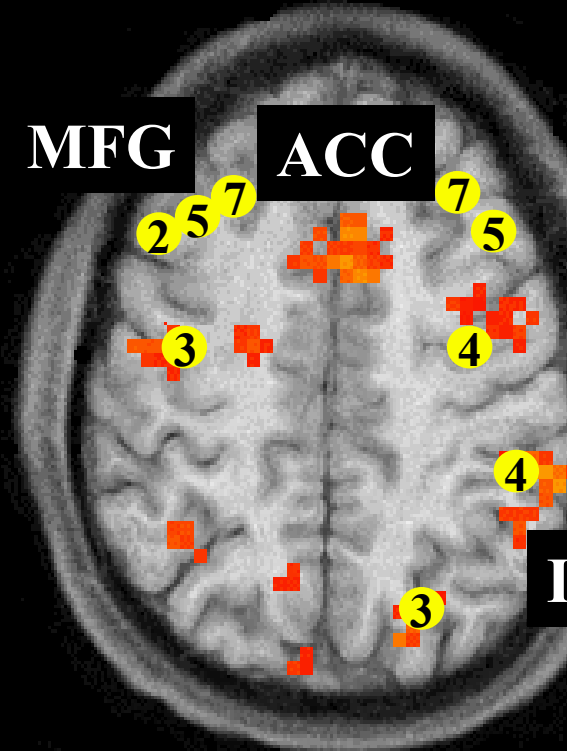
Z = +55

Z = +45

Z = +40





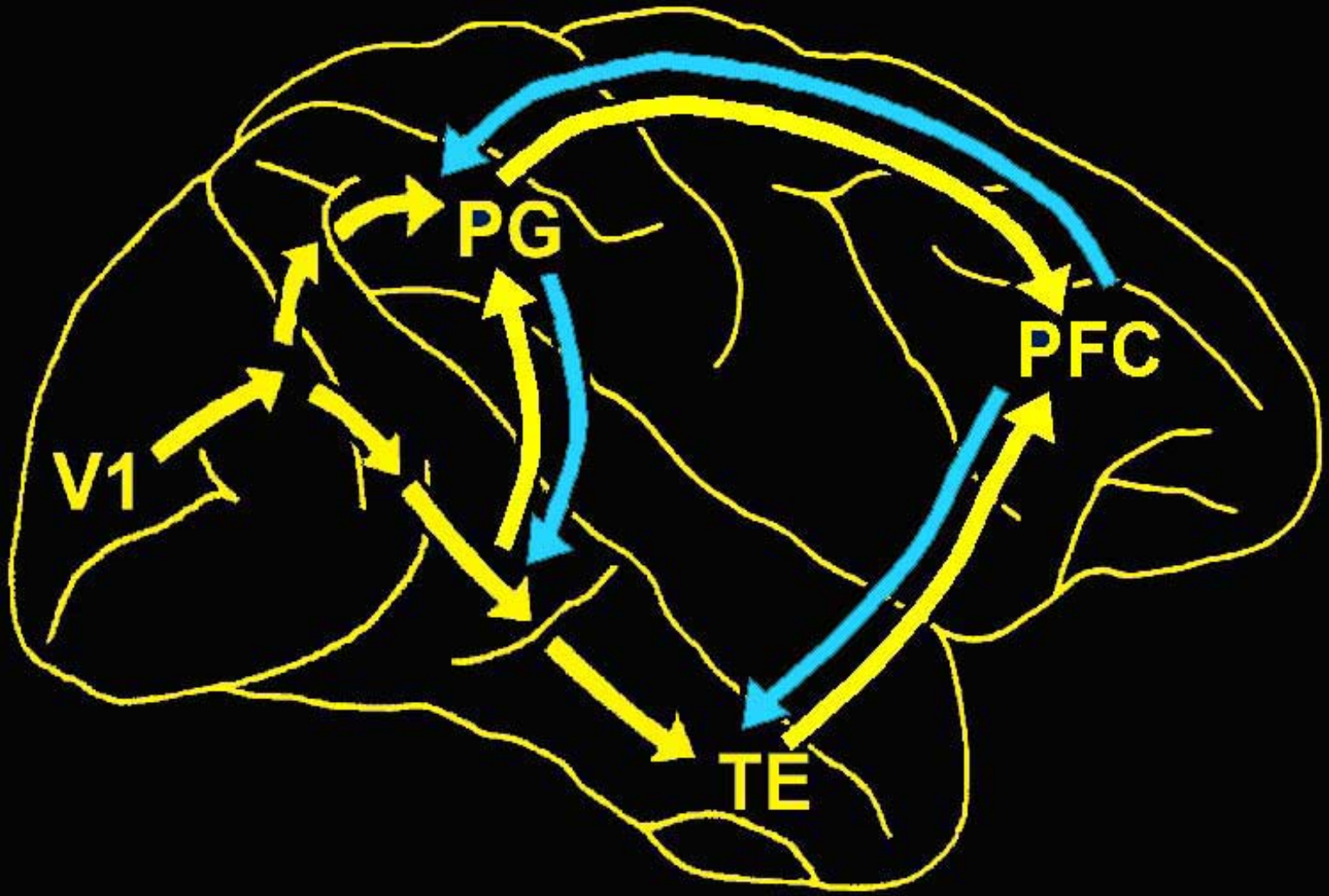


[1] Corbetta et al, 1993
[2] Fink et al, 1997
[3] Nobre et al, 1997
[4] Vandenberghe et al, 1997

[5] Corbetta et al, 1998
[6] Culham et al, 1998
[7] Kastner et al, 1999

[8] Rosen et al, 1999
[9] Corbetta et al, 2000
[10] Hopfinger et al, 20

Top-Down Modulatory Influences on Ventral Stream Areas



ypothesis:

sterior parietal cortex is one source of top-down modulation
extrastriate visual areas, especially for tasks involving
ering out of distracting information.

ediction:

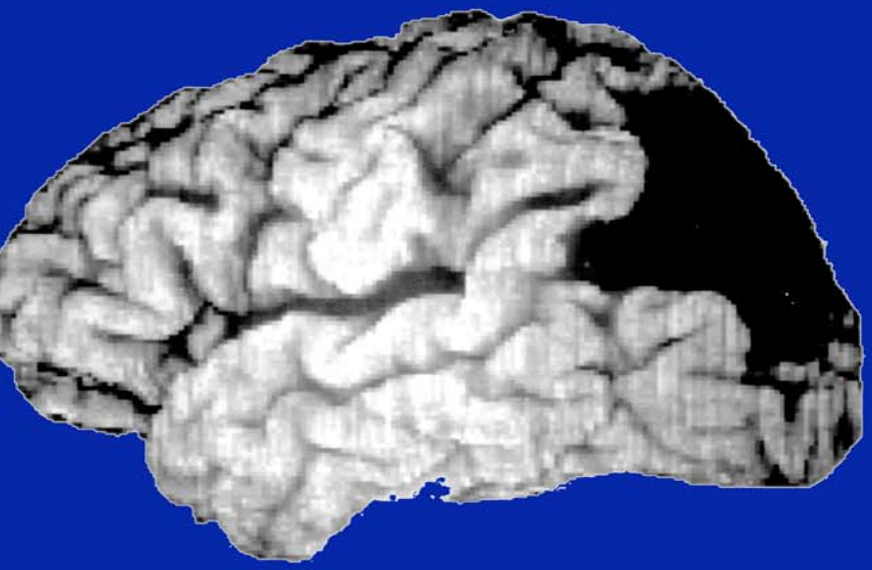
sions involving posterior parietal cortex will result in
paired attentional filtering similar to the deficit observed
lowing extrastriate lesions.

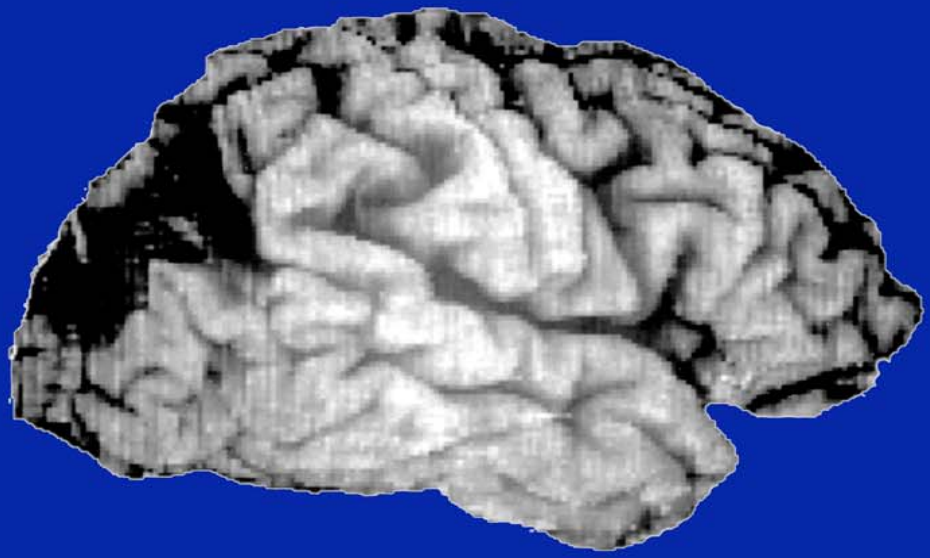
est by:

navioral study of a patient with bilateral focal lesions of
rietal cortex.

Patient R.M.

- 65-year old male.
- Bilateral posterior parietal lesions due to two embolic infarcts.
- Lesions encompass primarily Brodmann's areas 7 and 39; also include some of areas 5 and 19.



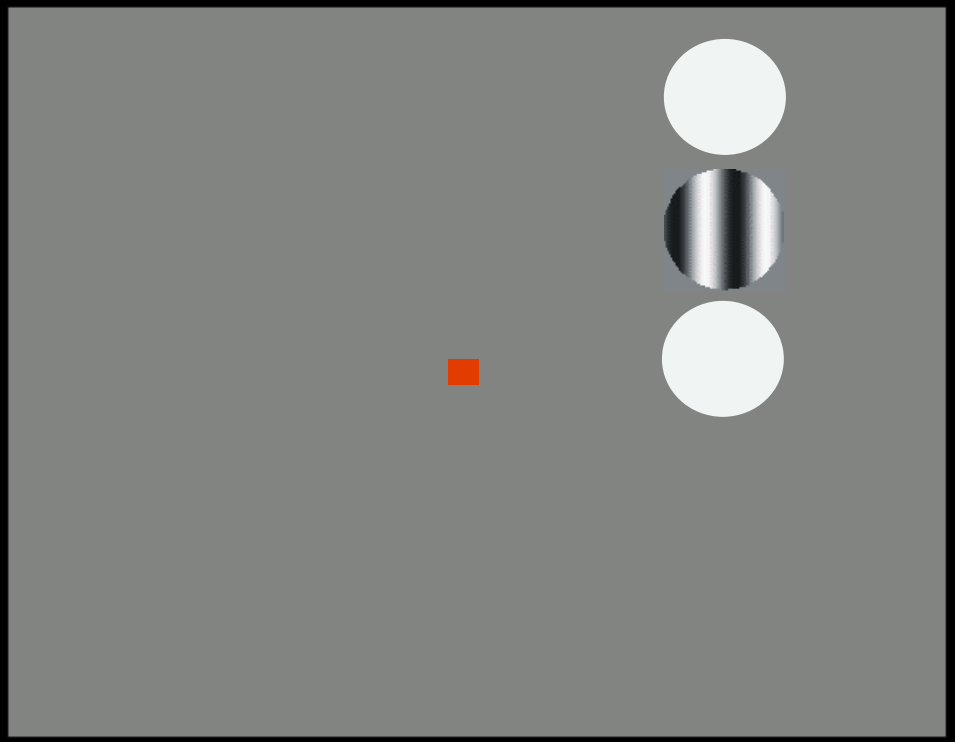


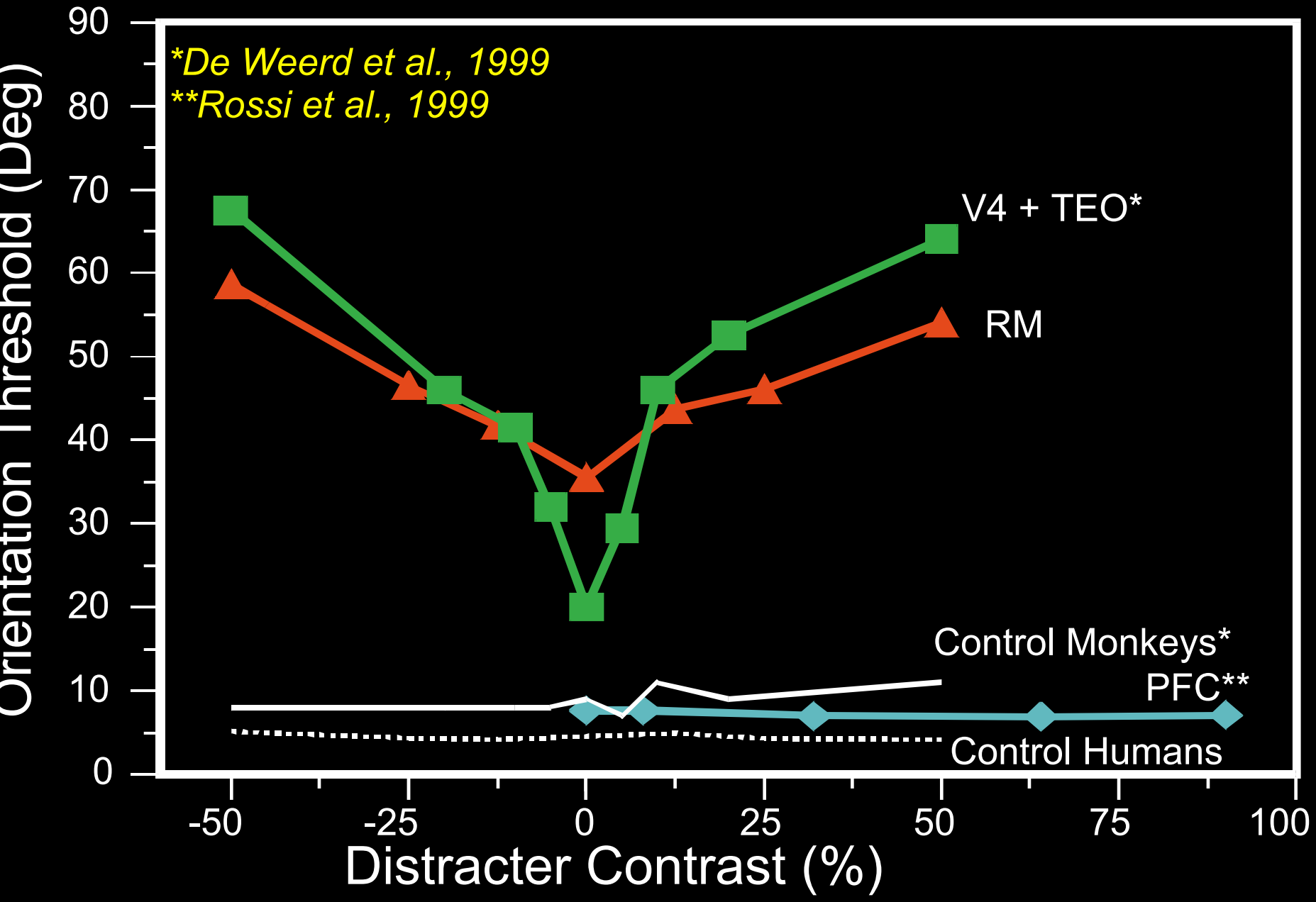
ask: Orientation Discrimination with Distracters

--Subject indicates whether object is/is not vertical.

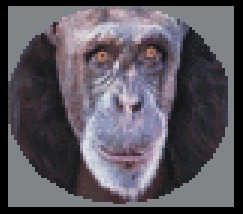
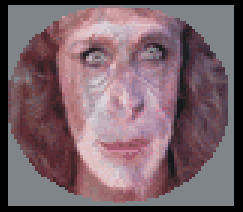
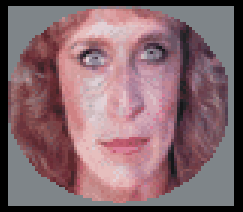
--Non-vertical orientation varies from 1.3-90 deg. Orientation is adjusted in a staircase procedure.

--Distracter contrast varies from 0-50%.




*De Weerd et al., 1999
**Rossi et al., 1999
V4 + TEO*
RM
Control Monkeys*
PFC**
Control Humans
Orientation Threshold (Deg)
90
80
70
60
50
40
30
20
10
0
-50
-25
0
25
50
75
100
Distracter Contrast (%)

Examples of Morphed Stimuli

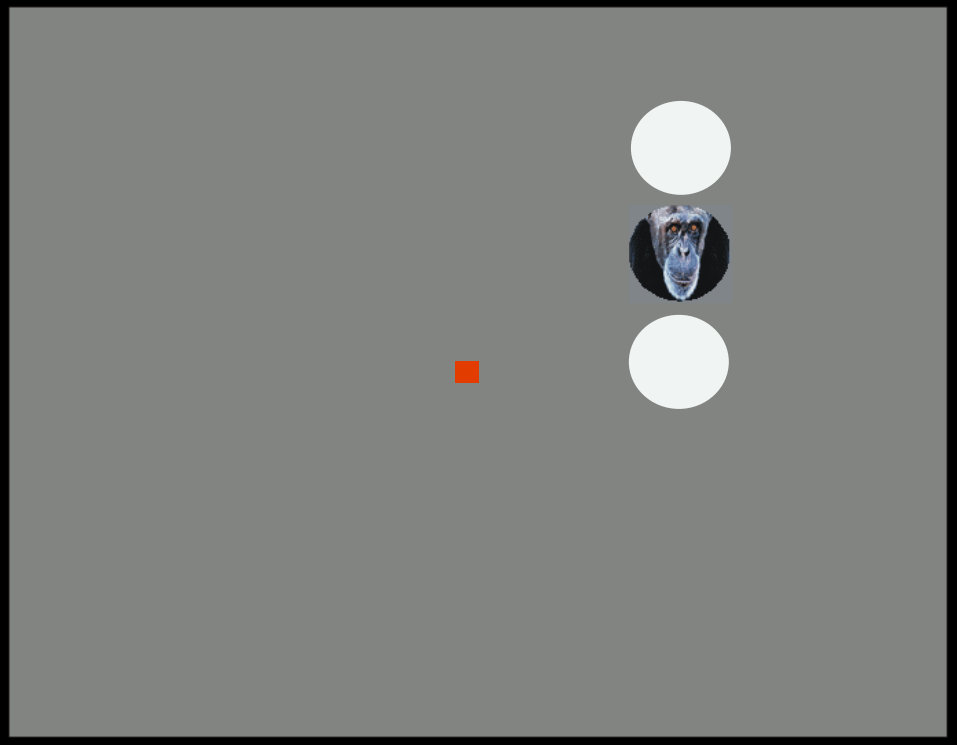
# of steps	
0	
263	
640	
800	
1000	

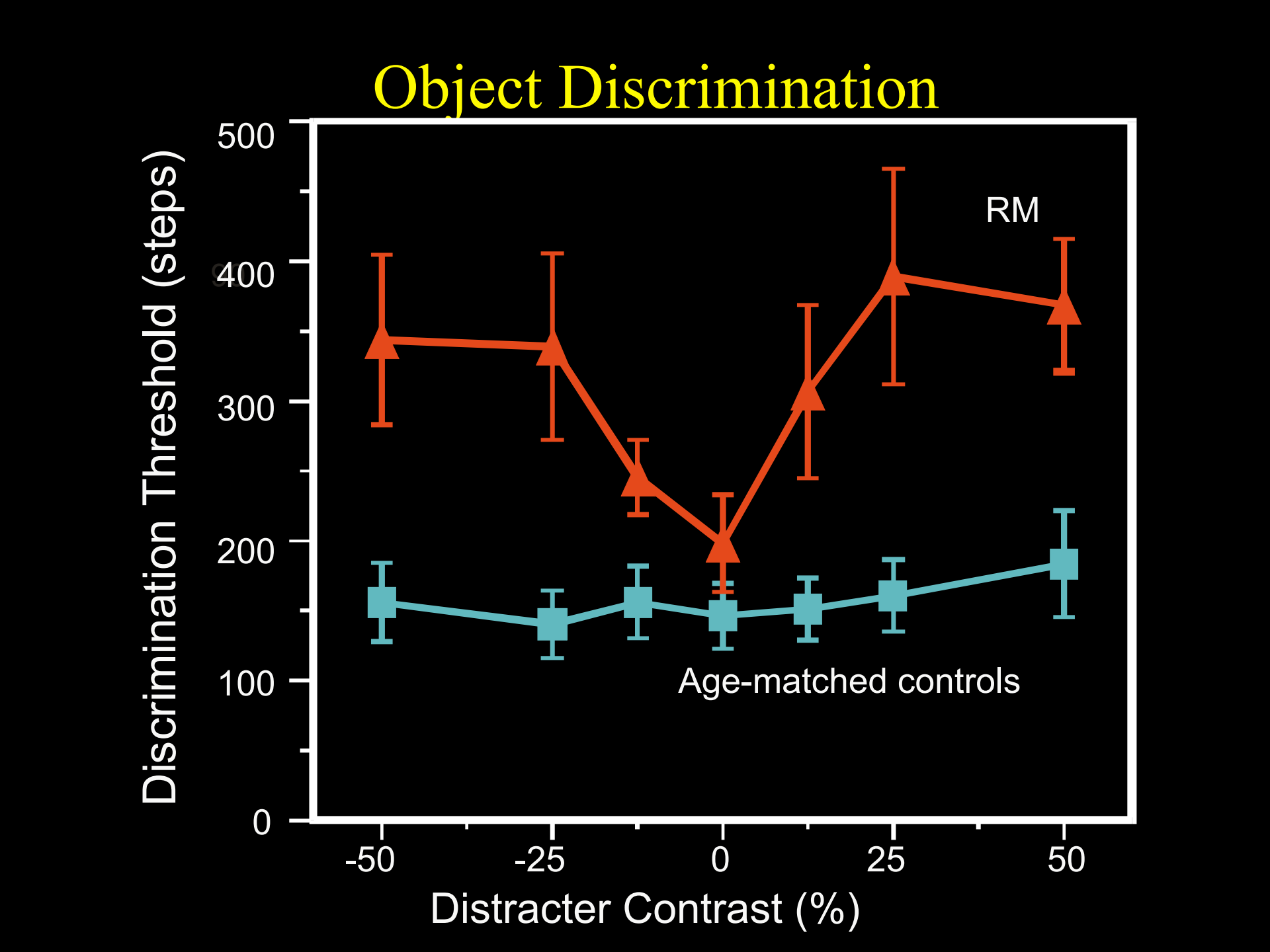
Task: Object Discrimination with Distracters

--Subject indicates whether object is/is not target.

--Morphed object identity (i.e. similarity to target) is adjusted in a staircase procedure.

--Distracter contrast varies from 0-50%.

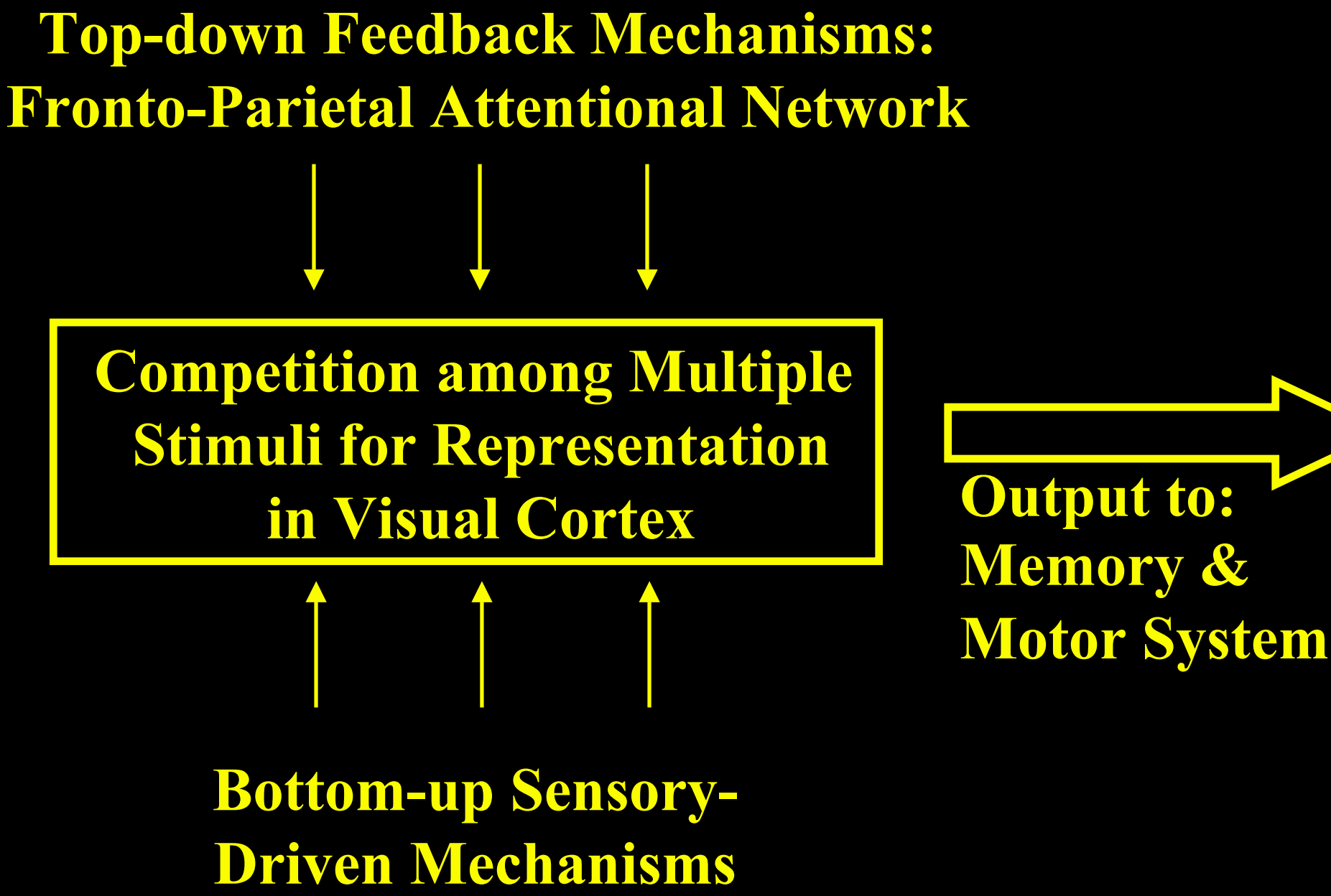



Object Discrimination
Discrimination Threshold (steps)
500
400
300
200
100
0
RM
Age-matched controls
-50
-25
0
25
50
Distracter Contrast (%)

Summary: Patient R.M.

Lesions of parietal cortex cause filtering deficits similar to those caused by lesions of extrastriate visual cortex, a finding consistent with the hypothesis that parietal cortex modulates activity in areas V4 and TEO.

The absence of a similar filtering impairment in monkeys with extensive prefrontal lesions suggests a functional dissociation of top-down control pathways.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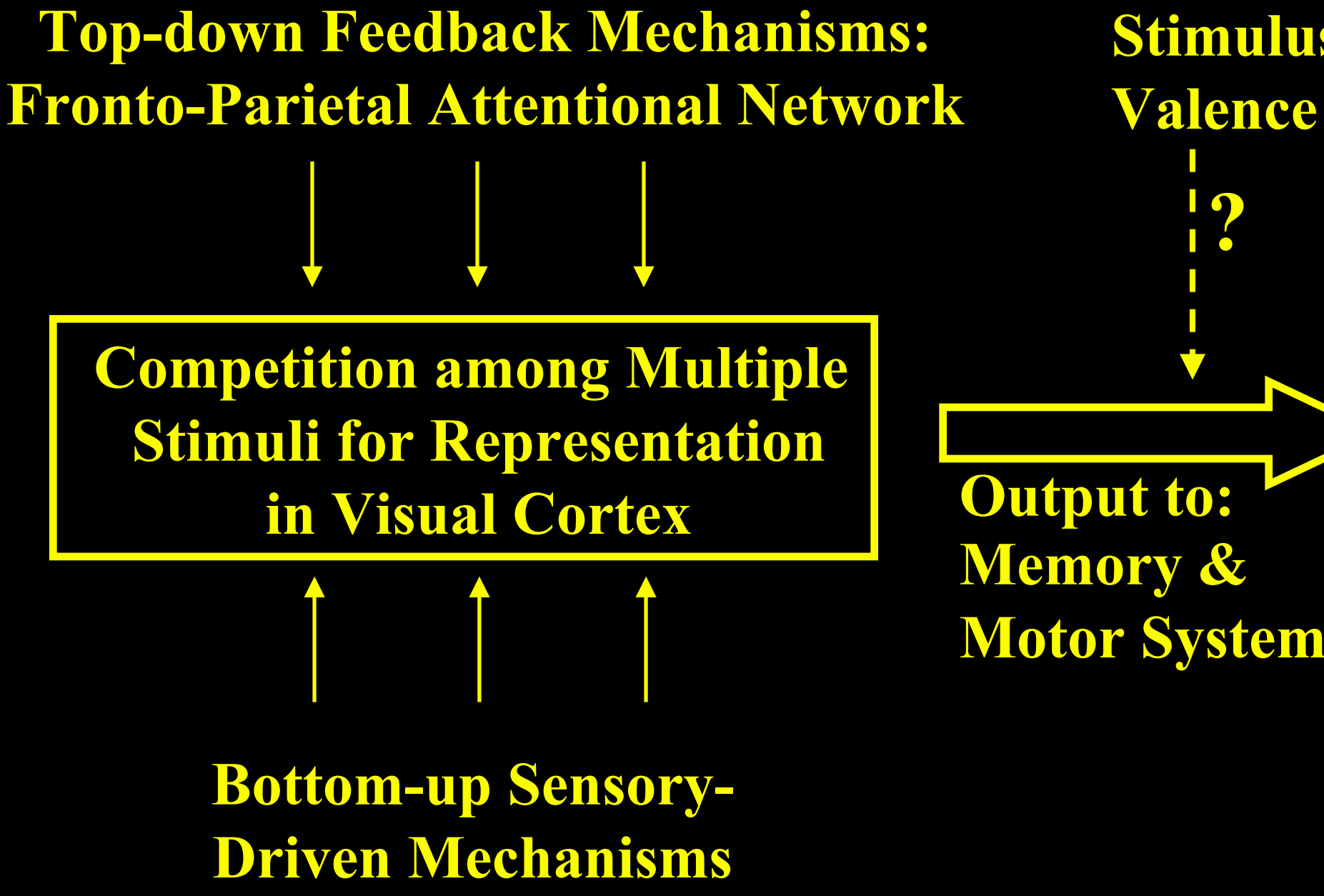
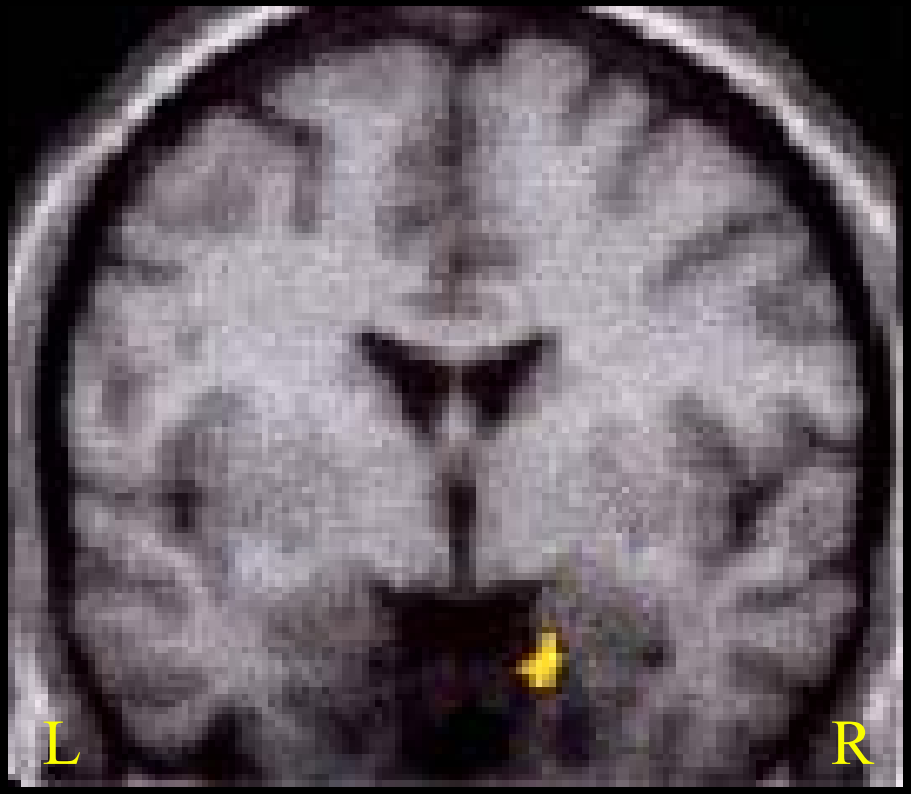

Top-down Feedback Mechanisms:
Fronto-Parietal Attentional Network
Stimulus
Valence
?
Competition among Multiple
Stimuli for Representation
in Visual Cortex
Output to:
Memory &
Motor System
Bottom-up Sensory-
Driven Mechanisms

Attentional resources are *not* required for processing stimuli with emotional content

- Galvanic skin responses are generated by negatively conditioned faces (angry) even when masked and undetected (Ohman et al., 1995)

- **Activity in the amygdala is evoked by negatively conditioned faces (angry) even when masked and undetected (Morris et al., 1998)**



Experimental Question

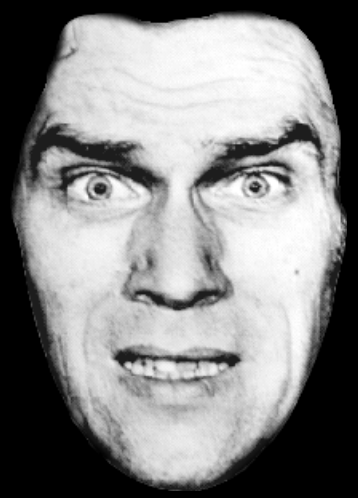
- **Is activity evoked by emotional stimuli automatic?**

or

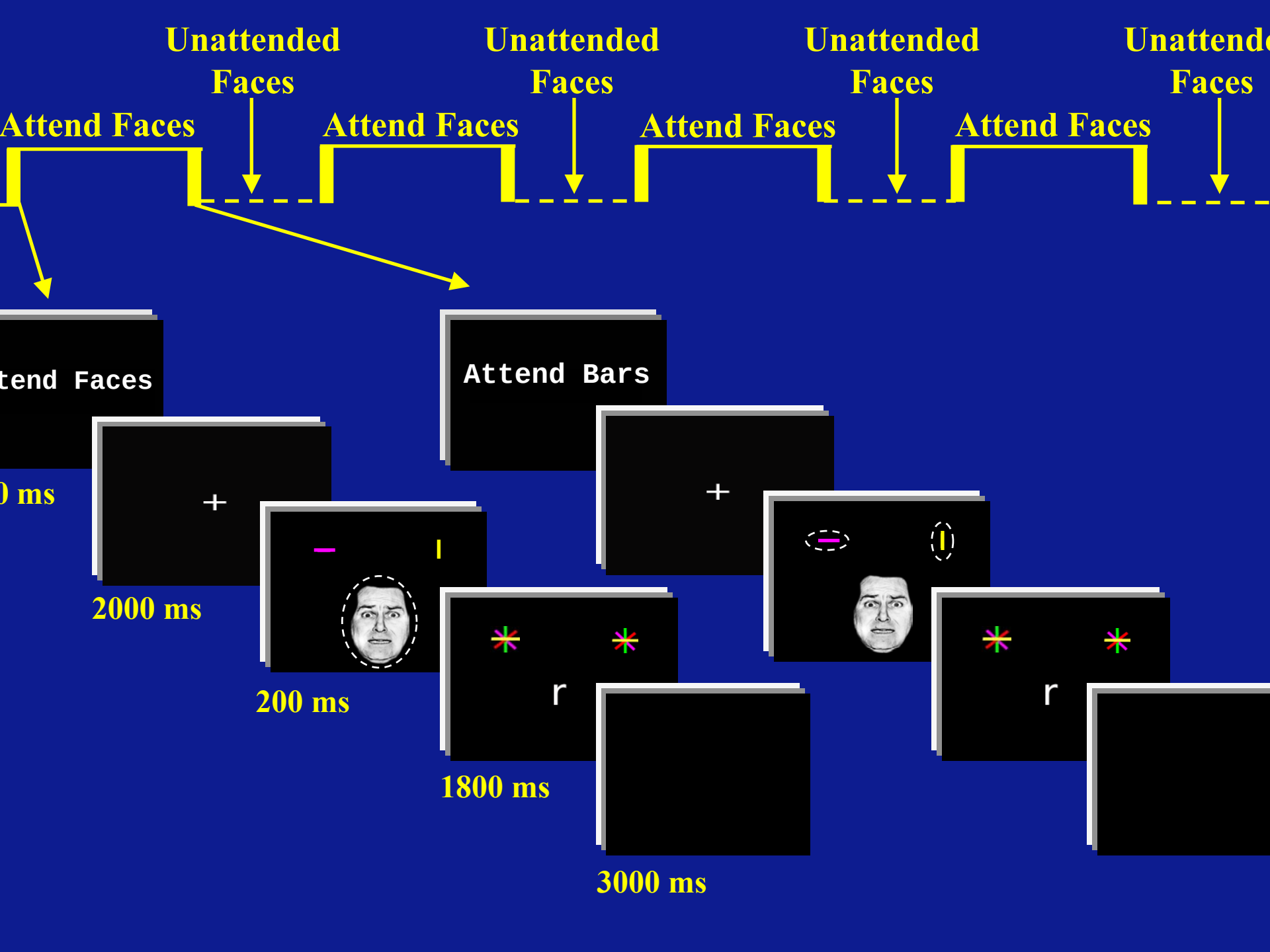
- **Does activity evoked by emotional stimuli require attention?**

Experimental Design

- Identical stimuli used in two types of trials:
  - Attend to faces: gender task
  - Attend to bars: orientation task
- Faces: fearful, happy, neutral (Ekman)

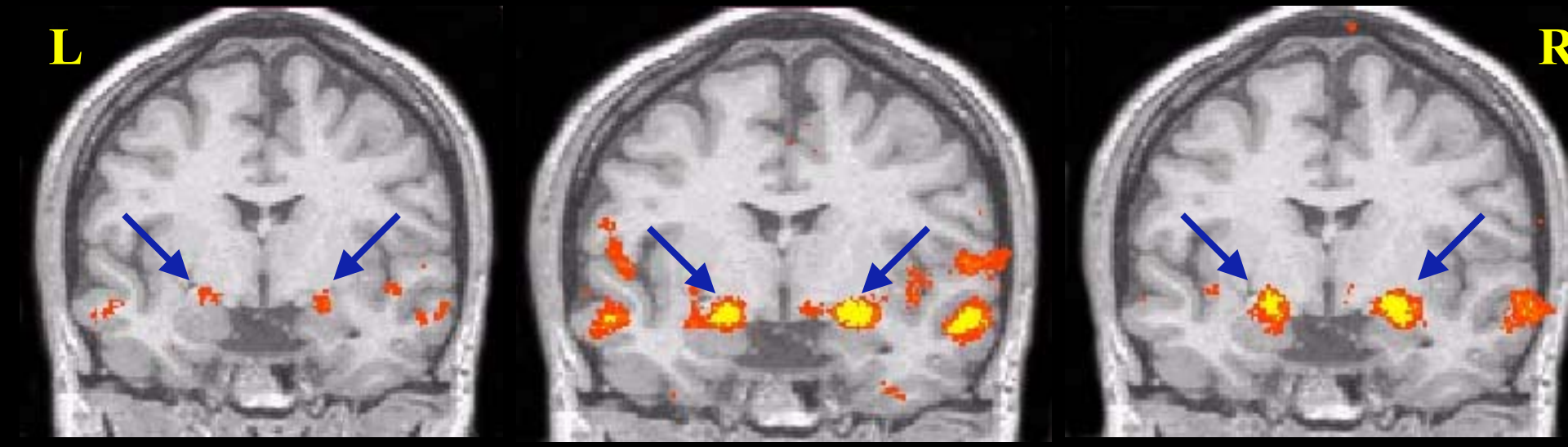


- 21 subjects scanned at 1.5T

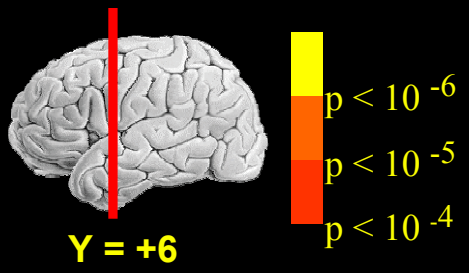

Unattended Faces
Unattended Faces
Unattended Faces
Unattend
Faces
Attend Faces
Attend Faces
Attend Faces
Attend Faces
tend Faces
0 ms
2000 ms
200 ms
Attend Bars
1800 ms
3000 ms
r
r

Amygdala is modulated by attention

attended (faces) > unattended (bars)

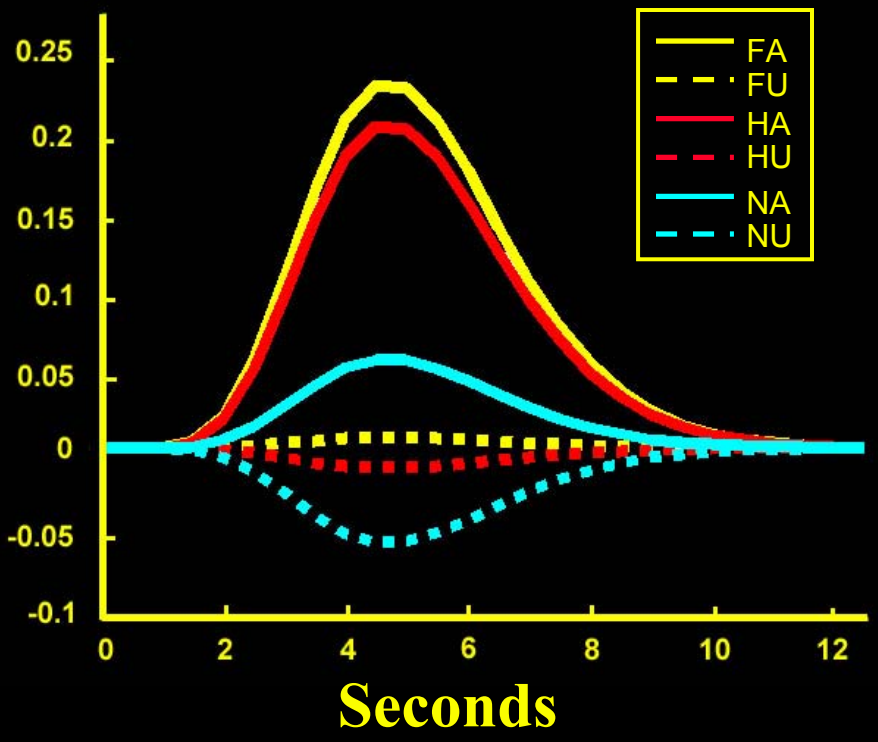


Neutral Fearful Happy

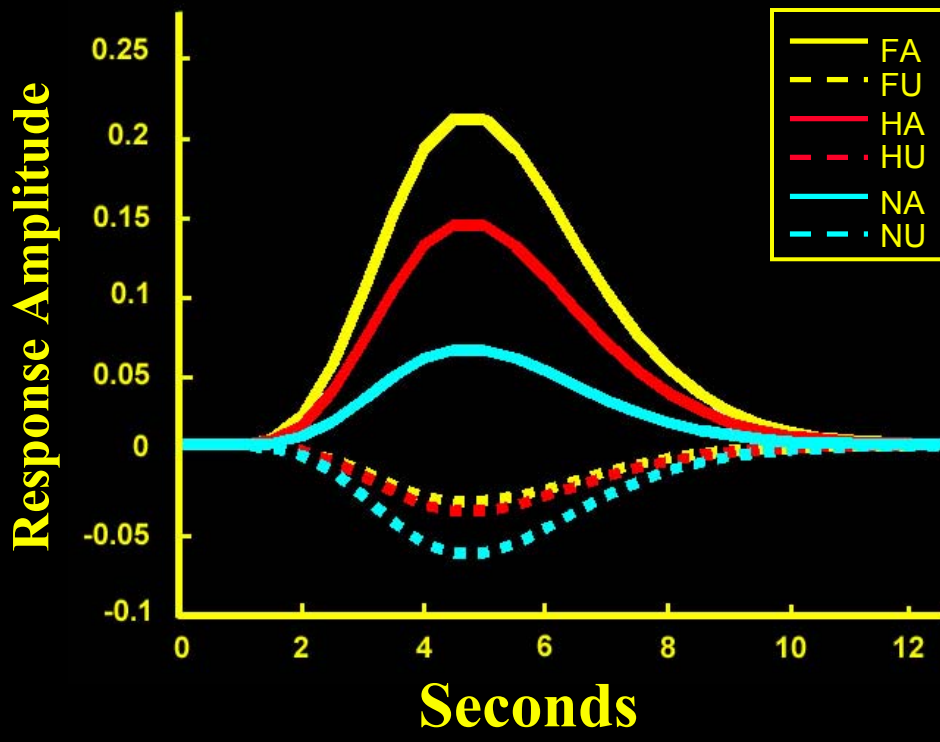


Attention is required for amygdala modulation by valence

Left Amygdala

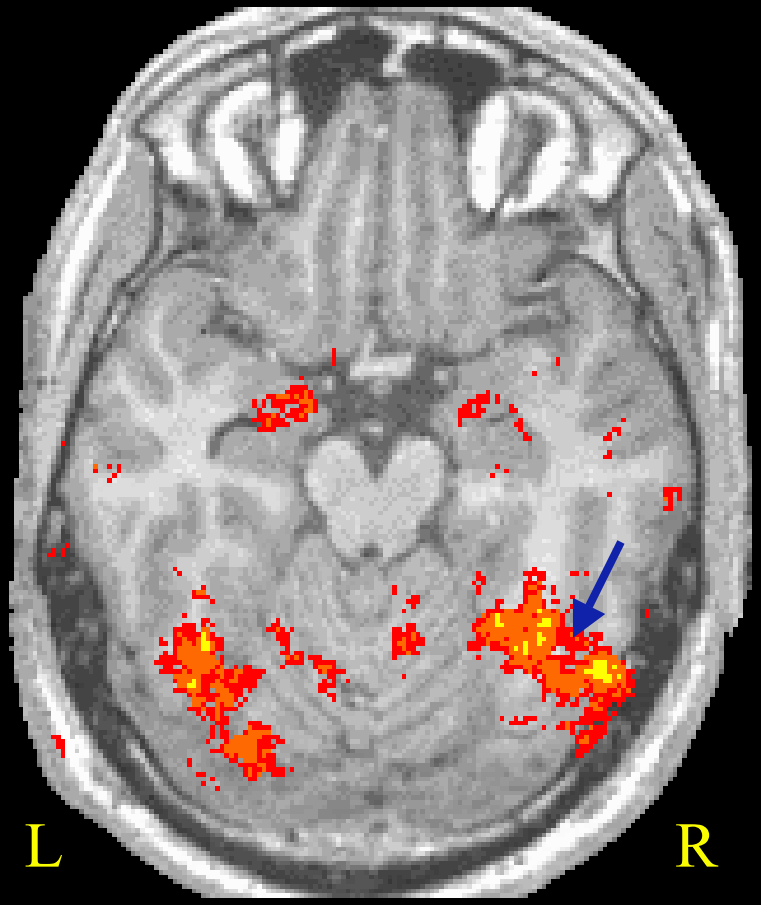


Right Amygdala

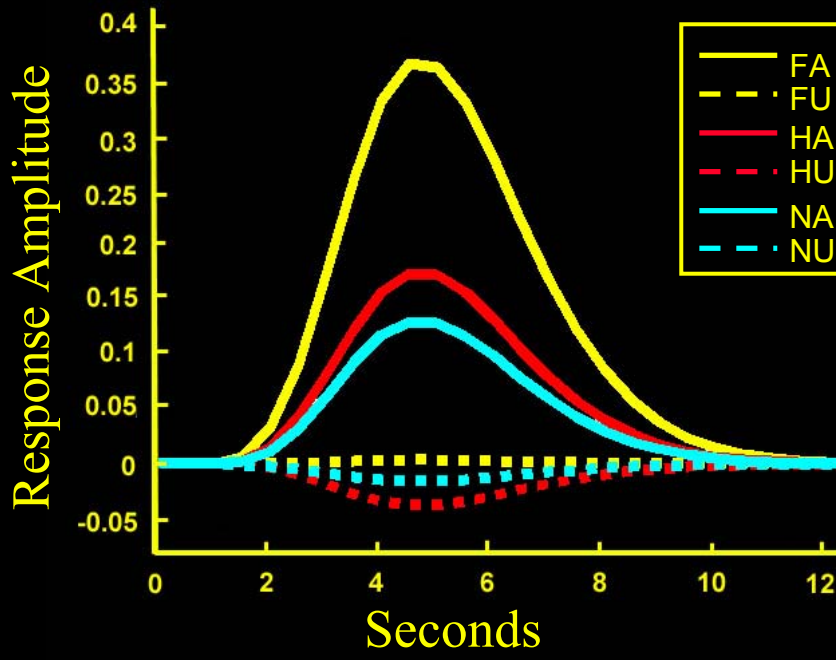


Occipitotemporal regions, including the fusiform gyrus, are modulated by valence

Fearful > Neutral



Right Fusiform



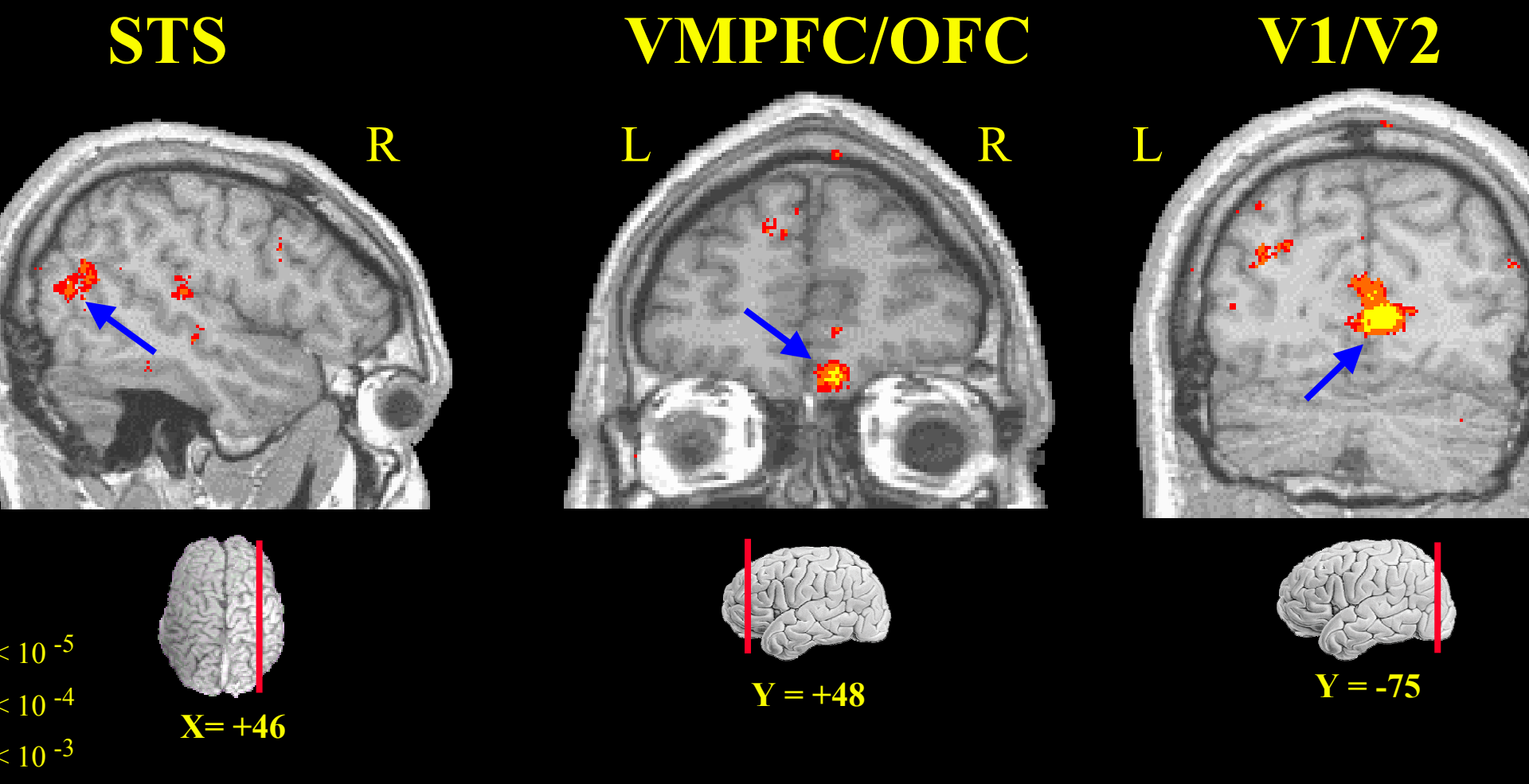
Z = -13

$p < 10^{-6}$

$p < 10^{-5}$

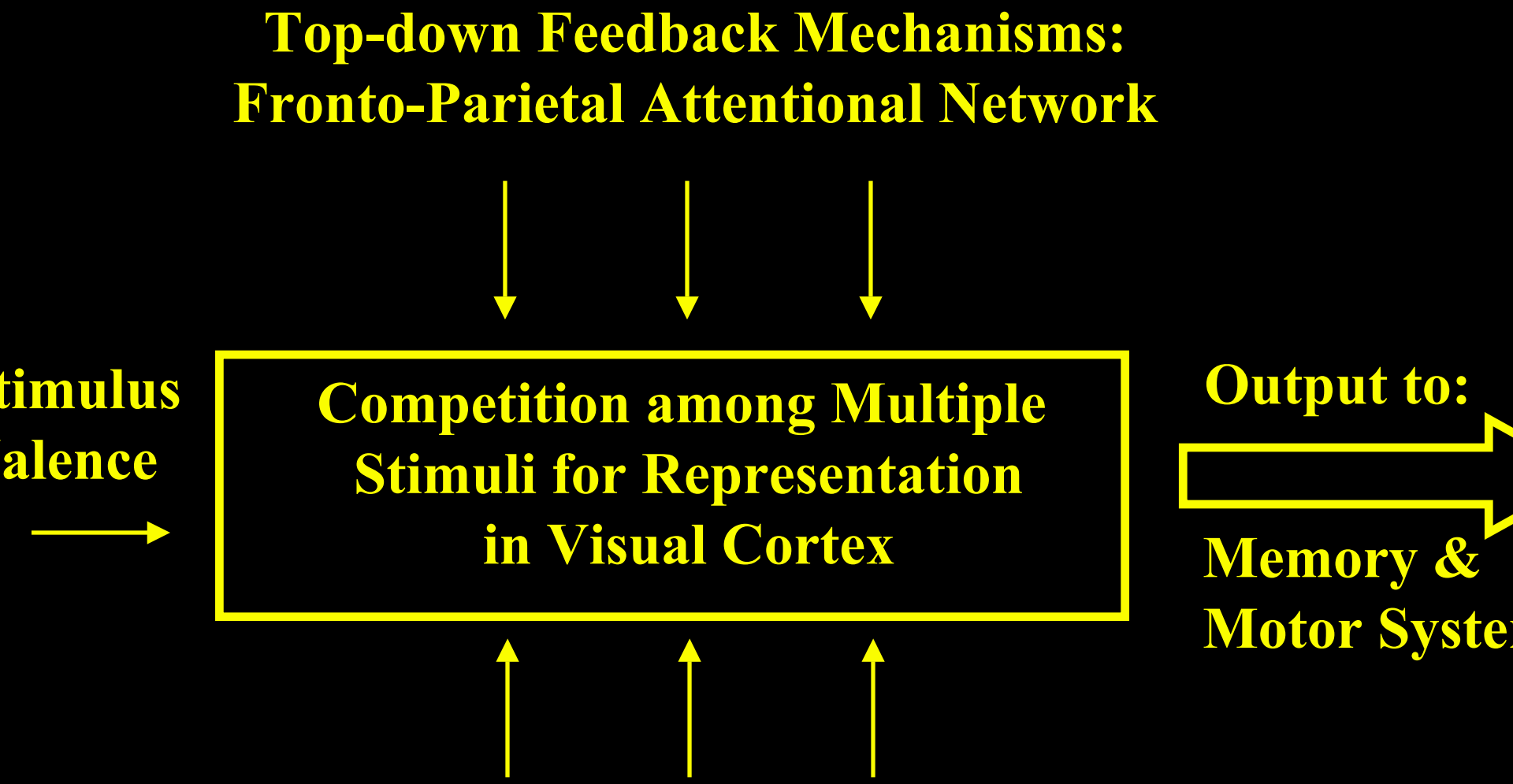
$p < 10^{-4}$

Other regions with significant attention X valence interactions



Summary: Visual Processing of Stimuli with Emotional Content

- **Valence modulates activity in several brain regions that process faces, not only the amygdala: occipitotemporal cortex, STS, VMPFC/OFC, and V1/V2.**
- **Attention is required for this valence effect in all structures, including the amygdala.**
- **Expression of valence is *not* automatic, it requires attentional resources.**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